

WHAT IS CLAIMED IS:

1. A composition useful for the formation of a passivating layer on a surface, the surface including more than about 5% copper by weight, comprising a solution having a pH equal to or greater than about 9 and having an oxidation potential sufficient to oxidize the surface to form copper oxides, wherein neither copper nor said copper oxides are substantially soluble in the composition.

2. The composition of claim 1, wherein the surface includes more than about 10% copper by weight.

3. The composition of claim 1, wherein the surface includes more than about 20% copper by weight.

4. The composition of claim 1, wherein the surface includes more than about 40% copper by weight.

5. The composition of claim 1, wherein the surface includes more than about 50% copper by weight.

6. The composition of claim 1, wherein the surface includes more than about 80% copper by weight.

7. The composition of claim 1, wherein said oxidation potential is more positive than about P_{pH} V relative to a saturated calomel reference electrode, where

$$P_{pH} = -0.05 \times pH + 0.425$$

pH being said pH of the composition.

8. The composition of claim 1, wherein said pH is between about 9 and about 10 and said oxidation potential is more positive than about -0.05V relative to a saturated calomel reference electrode.

9. The composition of claim 1, wherein said pH is between about 10 and about 11 and said oxidation potential is more positive than about -0.1V relative to a saturated calomel reference electrode.

10. The composition of claim 1, wherein said pH is between about 11 and about 12 and said oxidation potential is more positive than about -0.15V relative to a saturated calomel reference electrode.

11. The composition of claim 1, wherein said pH is between about 12 and about 13 and said oxidation potential is more positive than about -0.2V relative to a saturated calomel reference electrode.

12. The composition of claim 1, wherein said oxidation potential is more positive than a saturated calomel reference electrode by an oxidation potential selected from the group consisting of -0.2V, -0.15V, -0.10V, -0.05V, 0.0V, 0.05V, 0.10V, 0.15V, 0.20V, 0.25V, 0.3V, 0.35V, 0.40V, 0.45V, 0.50V, 0.55V, 0.60V, 0.65V and 0.7V.

12.5. The composition of claim 12, wherein said oxidation potential is more positive than a saturated calomel reference electrode by an oxidation potential of at least 0.0V.

13. The composition of claim 1, comprising

- a) a cation selected from the group of alkaline metal cations and alkaline earth metal cations; and
- b) an anion of a weak acid.

14. The composition of claim 13, wherein said cation is selected from the group consisting of Li^+ , Na^+ , K^+ , Rb^+ , Cs^+ , Be^{2+} , Mg^{2+} , Ca^{2+} , Sr^{2+} and Ba^{2+} .

15. The composition of claim 13, wherein said weak acid has a pKa of greater than about 0.

16. The composition of claim 13, wherein said anion is selected from the group consisting of acetate, adipate, bicarbonate, bisulfate, carbonate, chloroacetate, citrate, crotonate, cyanate, glutarate, dihydrogen phosphate, hydrogen phosphate, hydrogen sulfate, hydroxide, d-lactate, l-lactate, d-malate, l-malate, maleate, d-mandelate, l-mandelate, malonate, oxalate, permanganate, phosphate, hydrogen phthalate, phthalate, propanoate, succinate, sulfanilate, sulfate, d-tartarate and l-tartarate.

17. The composition of claim 13, wherein said cation is K^+ and said anion is carbonate.

18. The composition of claim 13, wherein said cation is Cs^+ and said anion is carbonate.

19. The composition of claim 13, further comprising an oxidizing agent.

20. The composition of claim 19, wherein said oxidizing agent is selected from the group consisting of phenols, peroxides, permanganates, chromates, iodates, iron salts, aluminum salts, sodium salts, potassium salts, phosphonium salts, chlorates, perchlorates, persulfates and mixtures thereof.

21. The composition of claim 19, wherein said oxidizing agent is selected from the group consisting of phenol, KMnO_4 , KIO_3 , KBrO_3 , $\text{K}_3\text{Fe}(\text{CN})_6$, $\text{K}_2\text{Cr}_2\text{O}_7$, V_2O_3 , H_2O_2 , HOCl , KOCl and KMgO_4 .

22. The composition of claim 19, wherein said oxidizing agent is KMnO_4 .

23. The composition of claim 1, substantially devoid of a film-forming agent.

24. The composition of claim 1, substantially devoid of a copper complexing agent.

25. The composition of claim 24, substantially devoid of ammonium cations.

26. The composition of claim 1, comprising abrasive particles.

27. The composition of claim 26, wherein said abrasive particles are metal oxides.

28. The composition of claim 27, wherein said metal oxide is selected from the group consisting of oxides of aluminum, cerium, germanium, silicon, titanium, zirconium and mixtures thereof.

29. The composition of claim 26, wherein said abrasive particles are chosen from the group comprising SiO_2 , CeO_2 , Al_2O_3 , SiC , Si_3N_4 and Fe_2O_3 .

30. The composition of claim 26, wherein said abrasive particles comprise between about 1% and 30% by weight of the composition.

31. A use of a composition of claim 1 for forming a passivating layer on a surface, said surface including more than about 5% copper by weight.

32. The composition of claim 31, wherein said surface includes more than about 10% copper by weight.

33. The composition of claim 31, wherein said surface includes more than about 20% copper by weight.

34. The composition of claim 31, wherein said surface includes more than about 40% copper by weight.

35. The composition of claim 31, wherein said surface includes more than about 50% copper by weight.

36. The composition of claim 31, wherein said surface includes more than about 80% copper by weight.

37. A method for the preparation of a composition useful for the formation of a passivating layer on a surface, the surface including more than about 5% copper by weight, comprising preparing a solution having a pH equal to or greater than about 9 and having an oxidation potential sufficient to oxidize the surface to form copper oxides, wherein neither copper nor said copper oxides are substantially soluble in the composition.

38. The method of claim 37, wherein said oxidation potential is more positive than a saturated calomel reference electrode by an oxidation potential selected from the group consisting of -0.2V, -0.15V, -0.10V, -0.05V, 0.0V, 0.05V, 0.10V, 0.15V, 0.20V, 0.25V, 0.3V, 0.35V, 0.40V, 0.45V, 0.50V, 0.55V, 0.60V, 0.65V and 0.7V.

38.5. The method of claim 38, wherein said oxidation potential is more positive than a saturated calomel reference electrode by an oxidation potential of at least 0.0V.

39. The method of claim 37, comprising

a) providing a solution comprising water;

b) adding to said solution a cation selected from the group consisting of alkaline metal cations and alkaline earth metal cations and an anion of a weak acid in an amount so that the pH of said solution is equal to or greater than about 9; and

c) adding to said solution an oxidizing agent so that the oxidation potential of said solution is more positive than about P_{pH} V relative to a saturated calomel reference electrode, where

$$P_{pH} = -0.05 \times pH + 0.425$$

pH being the pH of said solution.

40. The method of claim 39, wherein said oxidizing agent is selected from the group consisting of phenols, peroxides, permanganates, chromates, iodates, iron salts, aluminum salts, sodium salts, potassium salts, phosphonium salts, chlorates, perchlorates, persulfates and mixtures thereof.

41. The method of claim 37, further comprising adding abrasive particles to said solution.

42. The method of claim 41, wherein said abrasive particles are metal oxides.

43. The method of claim 42, wherein said metal oxide is selected from the group consisting of oxides of aluminum, cerium, germanium, silicon, titanium, zirconium and mixtures thereof.

44. The method of claim 41, wherein said abrasive particles are chosen from the group comprising SiO_2 , CeO_2 , Al_2O_3 , SiC , Si_3N_4 and Fe_2O_3 .

45. The method of claim 41, wherein said abrasive particles comprise between about 1% and 30% by weight of said solution.

46. A method of forming a passivating layer on a surface, the surface including more than about 5% copper by weight, comprising contacting the surface with a composition of claim 1.

47. A method for planarizing a surface, the surface including more than about 5% copper by weight, comprising abrading the surface in the presence of a composition of claim 1.

48. The method of claim 37, 46 or 47, wherein the surface includes more than about 10% copper by weight.

49. The method of claim 37, 46 or 47, wherein the surface includes more than about 20% copper by weight.

50. The method of claim 37, 46 or 47, wherein the surface includes more than about 40% copper by weight.

51. The method of claim 37, 46 or 47, wherein the surface includes more than about 50% copper by weight.

52. The method of claim 37, 46 or 47, wherein the surface includes more than about 80% copper by weight.